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Assessing female sexual arousal with the labial thermistor: Response specificity and construct validity

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ABSTRACT

The labial thermistor offers several potential psychometric advantages over existing measures of female sexual response; however, the thermistor lacked data to support these presumed advantages, especially with respect to its discriminant validity. In this study, both the labial thermistor was worn simultaneously with the vaginal photoplethysmograph as women viewed films. They also indicated their level of subjective sexual arousal using a lever. The labial thermistor discriminated sexual from nonsexual arousing stimuli and was sensitive to different levels of sexual arousal. The correspondence of the instrument with subjective sexual arousal, measured using a continuous lever, was lower during the mildly arousing sexual film and higher during the maximally sexual arousing film. One woman reported that the labial thermistor was very uncomfortable, while others indicated no or mild discomfort from each instrument. The vaginal photoplethysmograph largely replicated the effects documented by the labial thermistor, although it did not discriminate sexual stimuli of different intensity nor correspond with women's continuous lever responses as closely during the more arousing stimulus. Difficulties recording simultaneously with these instruments are noted. The labial thermistor adequately discriminates between generally arousing and sexually arousing stimuli, increasing its utility as a measure for between-subject study designs.

While our physiological knowledge of female genitalia still is growing slowly (e.g., Yang et al., 2006; O'Connell et al., 1998), the gold standard measure of female sexual arousal is far from certain. Many physiological measures have been tested, including anal electromyography (Bohlen and Held, 1979); clitoral erection (Karacan et al., 1970); vaginal oxygenation (Wagner & Levin, 1978); vaginal, clitoral, and labial photoplethysmography (Palti and Bercovici, 1967; Tart, 1969 as cited in Zuckerman, 1971; Prause et al., 2005, respectively); vaginal, labial, breast and groin temperature (Fugl-Meyer et el., 1984; Henson et al, 1977; Abramson and Pearsall, 1983; Kukkonen et al., 2007); and magnetic resonance imaging (MRI, Deliganis et al., 2000), among others (for review see Zuckerman, 1971 and Janssen et al., 2006). Each measure has faced a variety of challenges including methodological (selection of regions of interest in MRI), practical (acceptability of the anal probe to potential research participants), and analytical (using difference from baseline or percentage of maximal response measures). The labial thermistor would offer several benefits over other measures, reviewed below, provided additional necessary research concerning several of its psychometric properties.

The labial thermistor is a small, sensitive thermistor attached to a labia minorum by means of a padded clip. Given the infrequent use of the labial thermistor, laboratories have tended to construct labial thermistors independently. Recommendations for design have been published only recently by Payne and Binik (2006). This has resulted in somewhat variable design specifics. Labial thermistors tend to share the general design of a metal clip padded at the end of one arm by medical-grade silicone and a thermistor permanently affixed to the facing arm with a sliding bead to adjust the clip tension. The experimenter typically places the device on the widest portion of the participant's labium minus. The tension is increased until the thermistor cord can be lightly tugged without dislodging the device. It is widely thought to produce fewer movement artifacts than the vaginal photoplethysmograph and to permit direct comparison between participants. These differences are discussed further below.

Temperature already has been explored as a potential indicator of sexual arousal in several different areas of the body. Temperature regulation in humans is a complex phenomenon, which is influenced by endocrine changes (Hardy, 1961). The endocrine changes themselves also are altered by sexual arousal in both men (for review see Kruger et al., 2002) and women (Exton et al., 1999). Temperature has been shown to increase reliably during sexual arousal in the groin area (Seeley et al., 1980), genital area (Kukkonen et al., 2007; Abramson et al., 1981), penis (Webster and Hammer, 1983), and labia minora

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(Henson et al., 1977). There also is evidence that temperature changes in the labia (Henson et al., 1977) and genital area (Kukkonen et al., 2007) converge with subjective measures of sexual arousal. Temperature does not appear to increase in non-genital areas during sexual arousal such as the sternum (Henson et al., 1977), thigh (Kukkonen et al., 2007), or breast (Henson et al., 1977; see Abramson and Pearsall, 1983 for contrasting evidence of pectoral heat in contrast to knee-rubbing control condition). Evidence of vaginal temperature change with sexual arousal is mixed, with some documenting decreases (Fugl-Meyeret al., 1984) and others documenting increases (in response to pelvic nerve or medial preoptic area stimulation in rats, Giuliano et al., 2001) in temperature during sexual stimulation. Thus temperature measures of sexual arousal in women appear specific to sexual stimuli, restricted to the genital area, and convergent with other measures of sexual arousal.

The labia minora are particularly attractive as a measurement site for temperature due to their physiological properties. The labial epithelium is thinly keratinized, containing a slender layer of vessels in fibrous tissue that engorge (without rigidity) during sexual response (Yang et al., 2006). Menstrual phase changes appear to alter the labia only at the cytological level (Farage and Maibach, 2006) and menopausal status does not appear to affect sexual response, at least in nearby vulvar structures (Suh et al., 2004). They also are differentiated clearly anatomically from labia majora, clitoris, and clitoral hood, which should permit easy identification and attachment of same.

Labial temperature has been criticized as a method of measuring female sexual arousal due to poor evidence of its discriminant validity and a long latency to return-to-baseline. Instruments to measure sexual response must reliably differentiate sexual response from general physiological arousal (Zuckerman, 1971). Currently, no data address the thermistors' discriminant validity, questioning its utility in accurately capturing the construct of sexual arousal (Cronbach and Meehl, 1955). There is thermographic evidence, however, that female genitalia in general do not increase in temperature to non-sexual, arousing stimuli (Abramson et al., 1981; Kukkonen et al., 2007). One goal of this study is to test the ability of the labial thermistor to discriminate sexual arousal and general arousal in women. A slow return-to-baseline impedes the use of repeated-measures designs. Evidence increasingly suggests that this slow physiological denouement reflects a true process, not a problem of instrumentation. For example, residual blood pooling can be seen in female genitalia considerably after the offset of erotic stimulation in MRI (Maravilla et al., 2005) and thermographic (Henson et al., 1979) measures. Temperature is unique in that it permits intervention by cooling to decrease return-to-baseline times (Slob et al., 1996); unfortunately, cooling also may alter the normal course of sexual arousal. A second goal of this study is to assess whether repeated-measures designs can be effectively used with the labial thermistor without the use of a cooling procedure.

The vaginal photoplethysmograph is made of acrylic plastic and shaped like a menstrual tampon, measures vaginal wall blood flow using a light source and a photosensitive cell (Sintchak and Geer, 1975). The output of the photoplethysmograph can be quantified, applying different filters, as vaginal pulse amplitude (VPA, the alternating current component) and/or vaginal blood volume (VBV, the direct current component). Although the device is easy to use and has been demonstrated to be both sensitive and specific to sexual arousal (Laan et al., 1995), it also has several shortcomings. In particular, its relative scale limits its utility in between-subjects designs, whereas a measure of temperature is absolute. Also, vaginal motility (Carmichael et al., 1994; van der Velde and Everaerd, 2001) can disrupt VPA recordings, whereas movement artifacts are rare with the labial thermistor (Henson et al., 1979). Numerous reviews of vaginal photoplethysmography (e.g., Prause and Janssen, 2006) further describe that instrument for readers interested in additional details of vaginal photoplethysmography.

Given the limitations of alternative measures and the lack of a satisfactory approach to the improvement of their reliability and usability, the further development of the labial thermistor is warranted. The present study thus evaluates the discriminant validity of the labial thermistor and its utility in a repeated-measures study design. Additionally, the study attempts to replicate previous findings supporting the measures' convergent validity by simultaneously assessing a subjective measure of sexual arousal and vaginal photoplethysmography.

1. Methods

1.1. Participants

Twenty-three female participants between the ages of 18 and 55 ($M = 23.1$, $SD = 7.5$) were recruited through flyers and newspaper advertisements. These ads requested women over age 18 for a paid study in which “instruments monitor genital responses” during the viewing of “emotional” films. The advertisements provided both a website and phone number to contact for more information. At both sources the women received additional information, including the expected length of the study, laboratory setting, instruments to be used, and films to be viewed. Each woman received $25 for participating. The study was approved by the University's Human Subjects Committee.

1.2. Film stimuli

The participants were shown three, 5-minute film excerpts. Two of these depicted consensual, erotic, heterosexual encounter, edited to equal parts kissing/foreplay, oral sex being performed on the man and then the woman, and penile–vaginal intercourse (Pinowski, 1994; Royalle, 2003). One of these sexual films (Royalle, 2003) was selected by piloting to induce moderate levels of sexual arousal to test for a dose–response instrument relationship indicating sensitivity. This method of selection appears to have been effective (see Results section), which may have been due to the spontaneous verbal report of several participants that the less sexually-arousing film appeared dated due to the hair and clothing of the participants. The maximally sexually arousing film evoked the highest reports of sexual arousal in a previous study (Janssen et al., 2003) and excludes low base rate content unlikely to be appealing to women (e.g., anal sex, Woodard et al., 2008). The third film depicted a threatening, nonsexual, anxiety-inducing excerpt of a dog attacking a woman and child who try to escape (King et al., 1983). In sum, each woman viewed a low intensity sexual film ($Sex_{low\ intensity}$), a high intensity sexual film ($Sex_{high\ intensity}$), and a non-sexual threatening film (Threat). (One additional sexual video had been edited to degrade the film quality for another study. These data are reported elsewhere and would not contribute to unequal habituation due to the random order of presentation.) The order of the films was randomized. A documentary film about underwater creatures (National Geographic, 1995) was shown for 15 min before the start of test films to establish a baseline. A continuation of this film also was shown during 10-minute return-to-baseline intervals.

1.3. Procedure

All of the women who expressed an interest in participating were contacted by phone. During this phone contact, a female research assistant described the instruments used in the research and the protocol in detail. After providing the opportunity for the women to ask additional questions, interested participants were scheduled for an informational tour of the laboratory. During the tour, each volunteer received an Informed Consent Statement to take home to read privately and was shown the room and instruments involved in